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Experimental Operations and Support for LITE

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Final Report

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This scope of this task was to provide for the setup, measurement and data analysis of current and future efforts related to high-power solid state lasers. Laboratory operations and fiber laser development support are discussed.

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I. INTRODUCTION

The SLIDERS contract encompassed several research efforts within the Semiconductor Laser Branch of the Laser Division, Directed Energy Directorate of the Air Force Research Laboratory. The scope of this contract included development, design, fabrication, procurement, management, operations and maintenance of optical, electronic, and mechanical systems, subsystems, and components. Principal efforts included theory and concept development, design analysis, laboratory operations, and semiconductor laser and diode-pumped laser development, operation and maintenance. Efforts also included the development, procurement, and operation of instrumentation to evaluate and characterize laser systems.

II. LITE EXPERIMENTAL SUPPORT

The objective of this task was to provide for the setup, measurement and data analysis of current and future efforts related to high-power solid-state lasers including support for fiber laser development.

Subsequent to the start of this task, Air Force management decided to move and consolidate several laboratories, including the laboratory where this work was to take place, to new facilities. In support of this effort the laboratory experiments were taken down and moved to a temporary location or packed. Laboratory benches, plumbing, wiring, and cabling were disconnected and equipment readied for the move.

Electrical modification and upgrades to the new lab area were designed and coordinated prior to the move. The move of optical tables and equipment was subcontracted and the move efforts were coordinated. Once the move was complete optical tables were set up and positioned, equipment racks were assembled, and electrical modifications were completed, and equipment was unpacked. Tables were grounded to the building ground system, electrical boxes were run from under the floor and the table electric plug strips were rewired with longer cords. Additional storage space was obtained and numerous pieces of equipment were put into storage.

To avoid laboratory overcrowding, additional lab space was obtained. Upgrades and modifications to the new laboratory space were drawn up and subcontracted for completion. Equipment was moved into the new lab area and set up.

The consolidation of the various computers used for characterization experiments was completed. Programs from the computers were copied to a new computer and the old units turned in.

After the bulk of the move was completed and laboratory functionality was re-establishment, LITE program technical efforts continued. In support of LITE experimental efforts the linewidth of the 1.5 um laser and amplifier used for phasing experiments was measured with the Spex spectrometer at different power levels. The Spex spectrometer was set up and aligned with a HeNe laser. The spectrometer was tuned up and the resolution measured. A new computer was obtained to operate the spectrometer and gather data. The control software for the spectrometer did not have the correct driver for the serial port so communication with the Spex was lost. LabView was copied onto the system and a test program was written to communicate with the Spex. Once this program was running, a previously written spectrometer program was modified to operate the SPEX and take data.

Spectral measurements were made on an Optopower high power 975 nm pump laser, used to pump a 1.55 micron fiber laser. It was found that the Optopower device had no temperature control thus the output wavelength was fixed by the ambient temperature of the lasers. The spectrum was found to be comprised of several strong lines centered about 970 nm with a total width of about 5 nm, which changed with drive current. Without temperature control the output could not be tuned to the fiber laser absorption peak.

A second experiment was set up to provide an input for the IRE Polus fiber amplifier at 1.06 microns. A narrow linewidth YAG laser and an isolator were used. Various coupling optics were used to focus the light into a "panda" polarization preserving fiber. Measurements of the polarization at the output showed only 10 % polarization and the beam profile was non-uniform. A careful examination of the fiber ends showed some problems and new fibers are under construction. In addition, a camera and microscope objective were set up to image the fiber end to aid in proper light coupling into the fiber core.

A third experiment was set up to examine fiber non-linearities. At high powers, non-linear interactions in the fiber such as stimulated brillouin scattering (SBS) become a problem as forward propagating light is converted to a backward propagating wave. To examine possible methods to avoid SBS in a fiber amplifier, an experiment was set up to measure fiber SBS thresholds. To increase the SBS threshold a plan was drown up to broaden the spectrum of the oscillator. The output of the oscillator will be phase modulated to create spectral sidebands which should compete for SBS gain. Components for this experiment were gathered and tested, and set up.

A fourth experiment was started to look at issues with diode pump array lifetimes. This experiment will measure lifetime data and the arrays will subsequently be examined by material analysis experts at Wright Patterson AFB. An optical beam train was designed and components were specified for the data gathering and analysis. Purchasing activity for this experiment is ongoing.

III. CONCLUSION

Laboratory reorganization and consolidation curtailed technical activity on this task, however a number of fiber laser experiments were initiated. An SBS threshold setup was started. Measurement of SBS thresholds is important to help mitigate this nonlinearity in high power fiber lasers. A test bed was also started to investigate diode array pump lifetime issues, and to develop higher brightness fiber pumps. Continuation of these activities in crucial to the development of high power fiber lasers.

IV. PUBLICATIONS AND PRESENTATIONS

"Injection Locking Properties of Angled Grating Semiconductor Lasers", 31st Winter Colloquium on The Physics of Quantum Electronics, Salt Lake City, UT, January 2001.

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